



# Pointshop 3D

An Interactive System for Point-based  
Surface Editing

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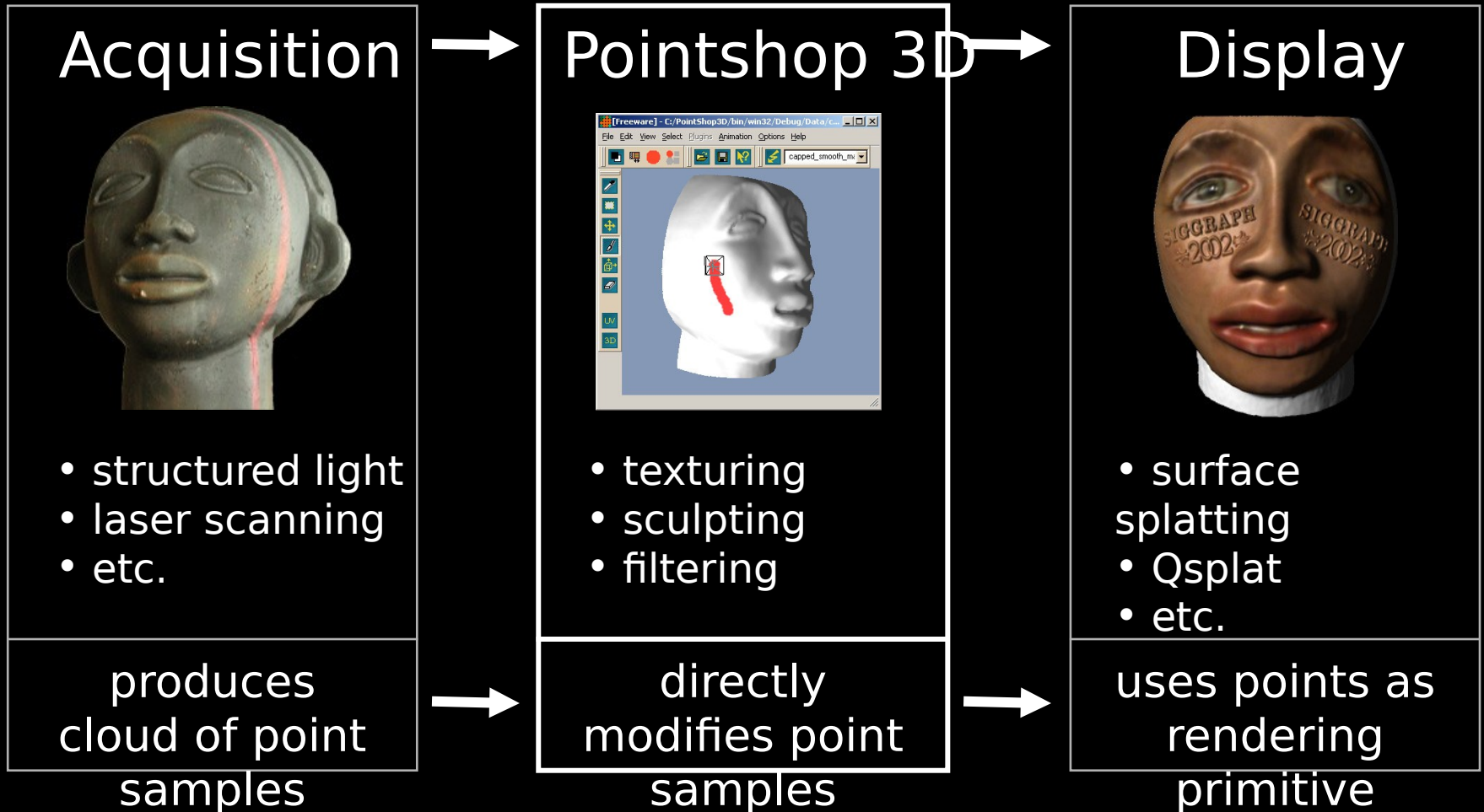


ETH Zürich

# Outline

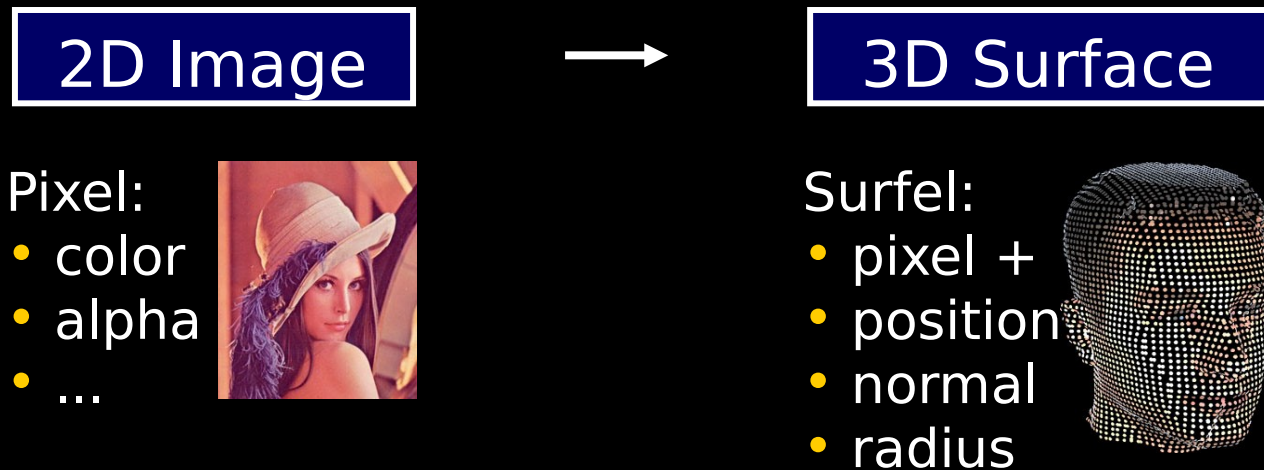
- Introduction
- Pointshop3D system components
  - Point cloud parameterization
  - Dynamic sampling
  - Editing operators
- Demo
- Conclusions

# Point-Based 3D Content Creation



# Pointshop 3D

- Generalizes 2D photo editing concepts and functionality to 3D point-sampled surfaces



- ⇒ Geometry editing: modify 3D positions and normals, e.g. sculpting and filtering

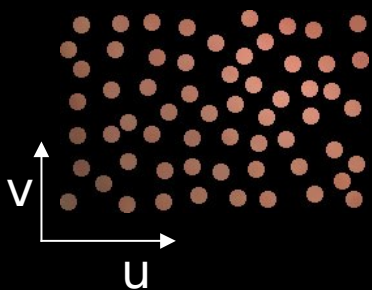
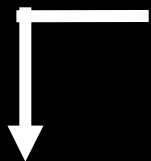
# Editing Operation



# Editing Operation

Parameterization

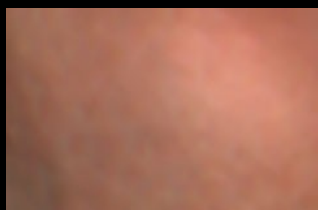
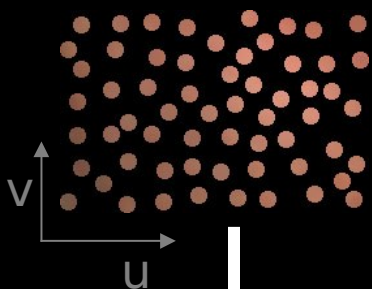
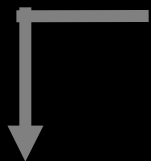
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# Editing Operation

Parameterization

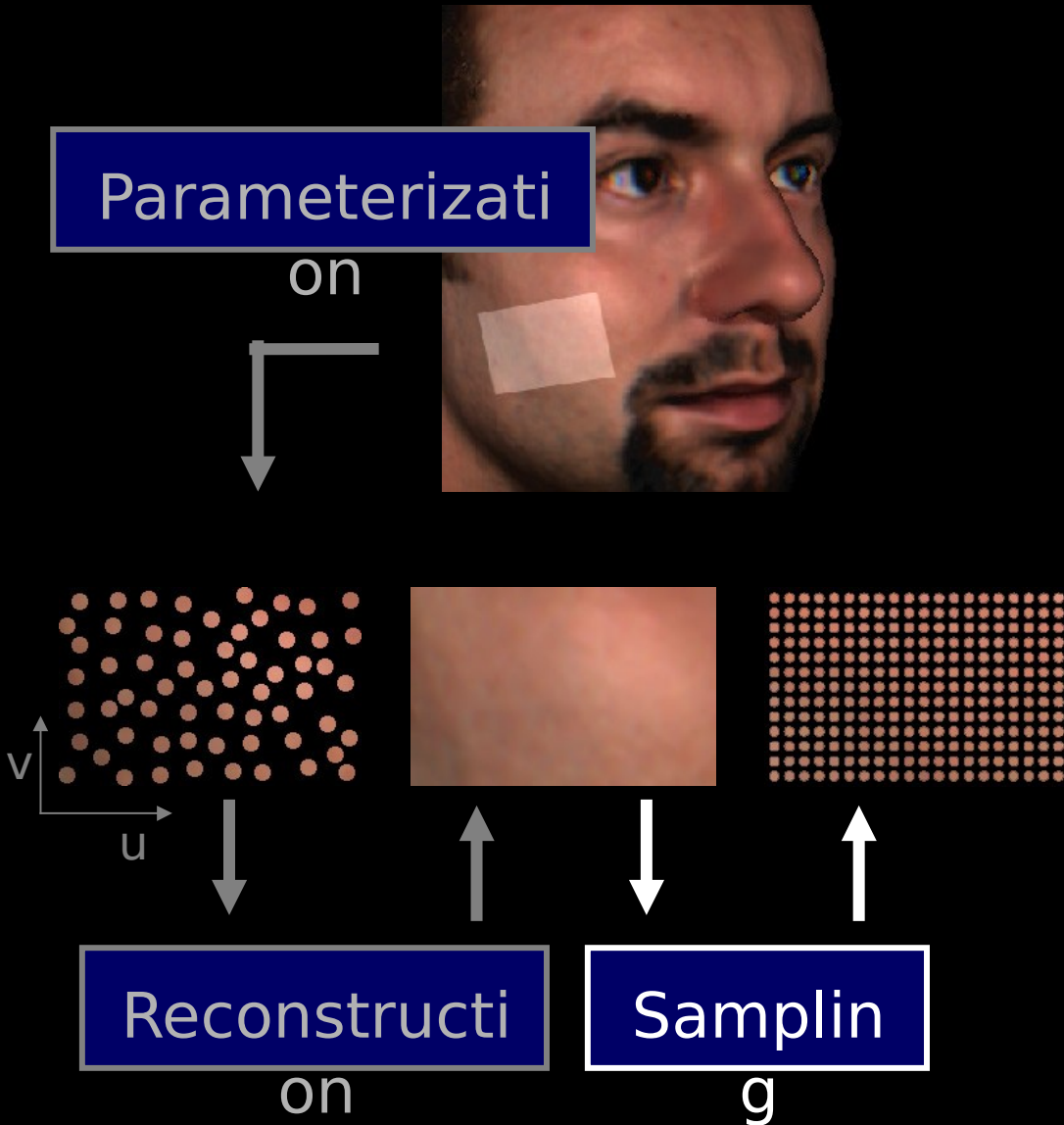
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Reconstruction

on

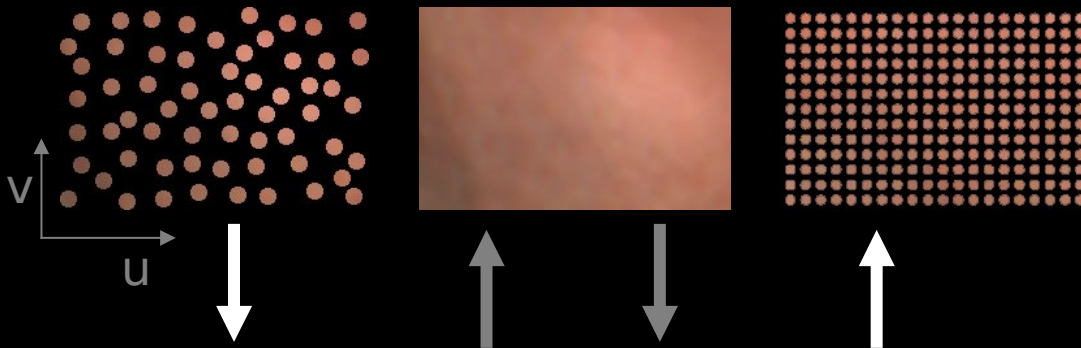
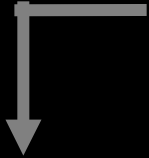
# Editing Operation



# Editing Operation

Parameterization

on

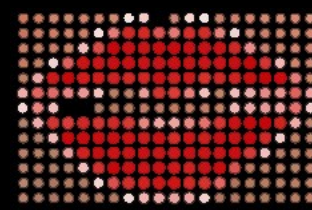
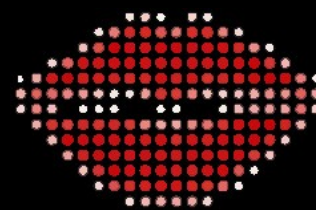
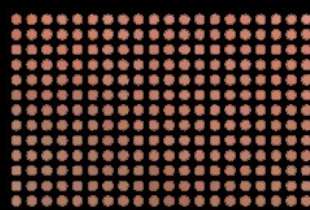
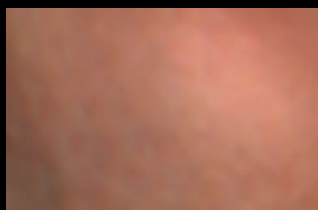
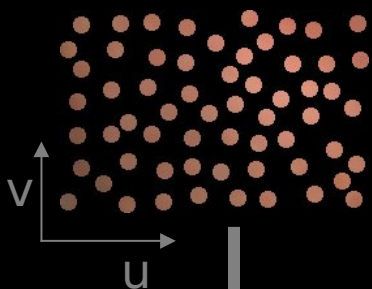
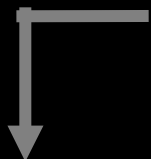


Resampling Operator

# Editing Operation

Parameterization

on



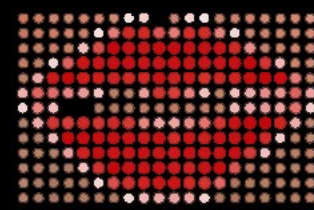
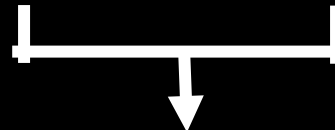
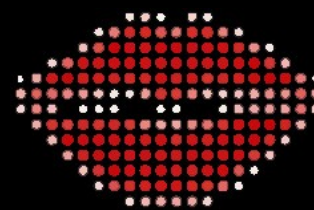
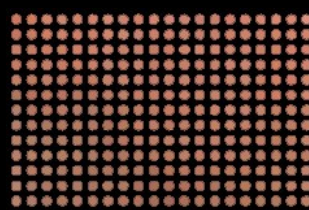
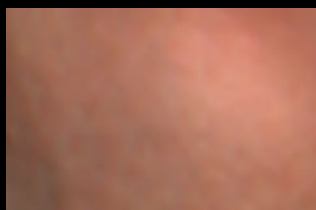
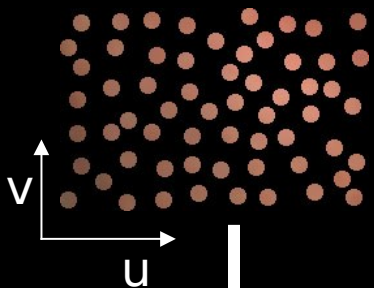
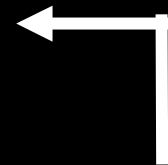
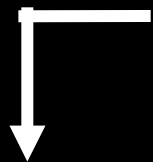
Resampling Operator

Editing Operator

# Editing Operation

Parameterization

on



Resampling Operator

Editing Operator

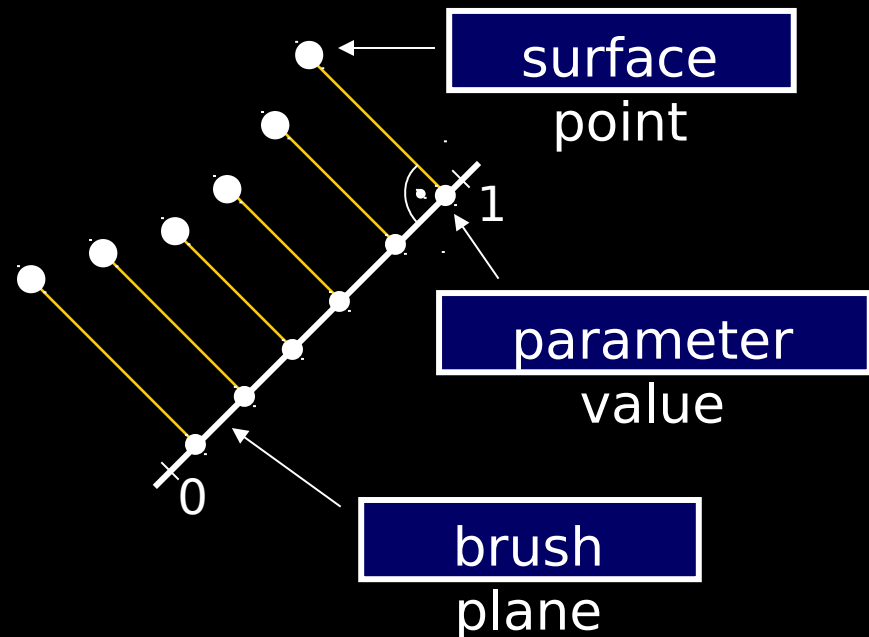
# Key Components

- Point cloud parameterization
- Dynamic resampling
- Editing operator



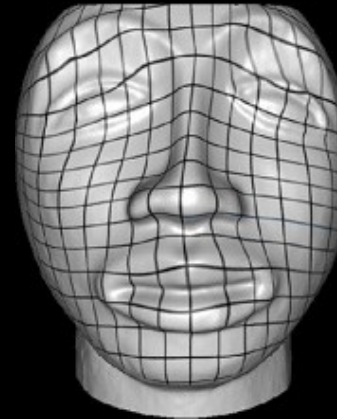
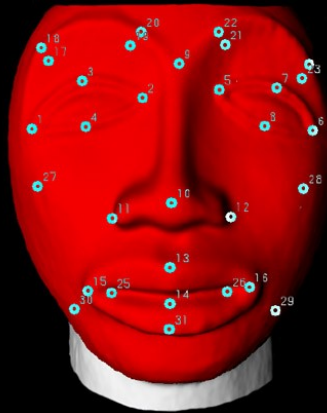
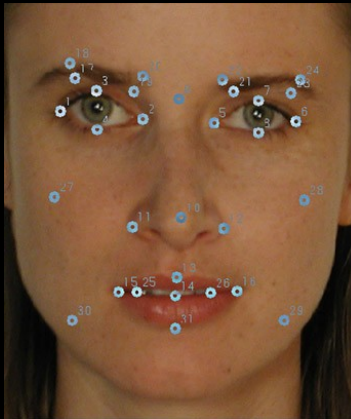
# Point Cloud Parameterization

- Brush interaction
  - Parameterize by orthogonal projection



# Point Cloud Parameterization

- Selection interaction
  - Constrained minimum distortion parameterization

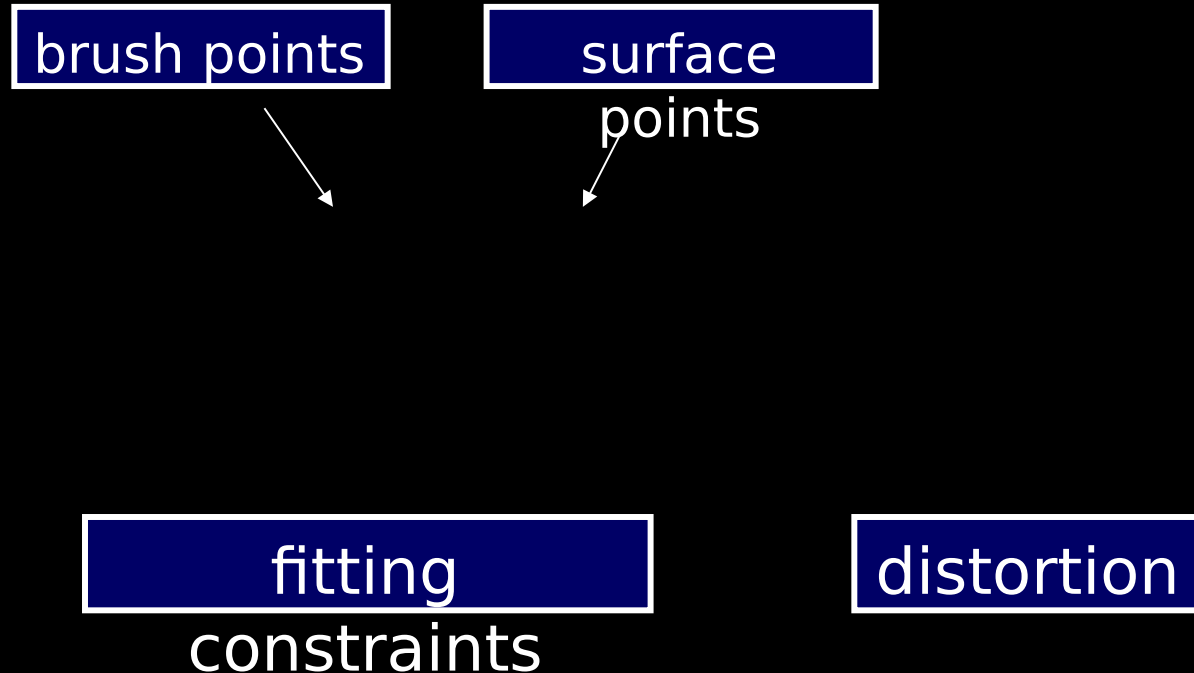


Constraints

Minimum Distortion

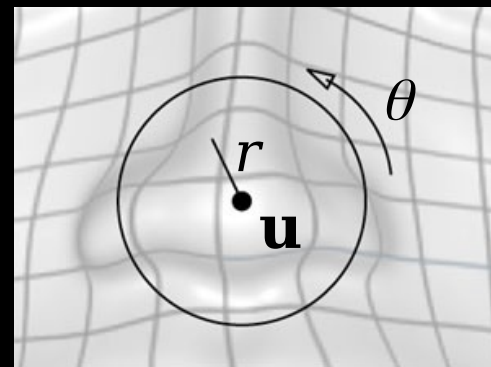
# Point Cloud Parameterization

- Minimize objective function



# Point Cloud Parameterization

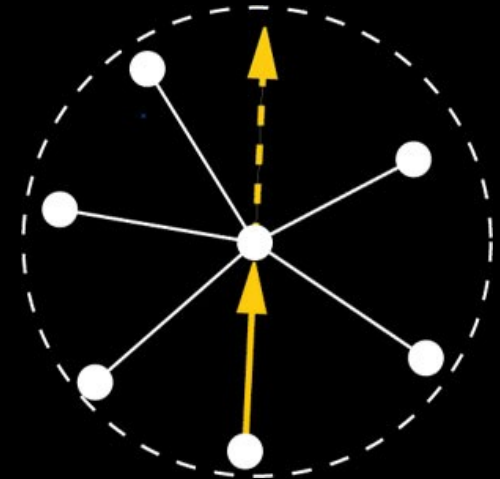
- Measuring distortion



- Integrates squared curvature using local polar re-parameterization

# Point Cloud Parameterization

- Discrete formulation:
  - Approximate second derivative with divided differences
  - Discretize integral using normal sections based on k-nearest neighbors

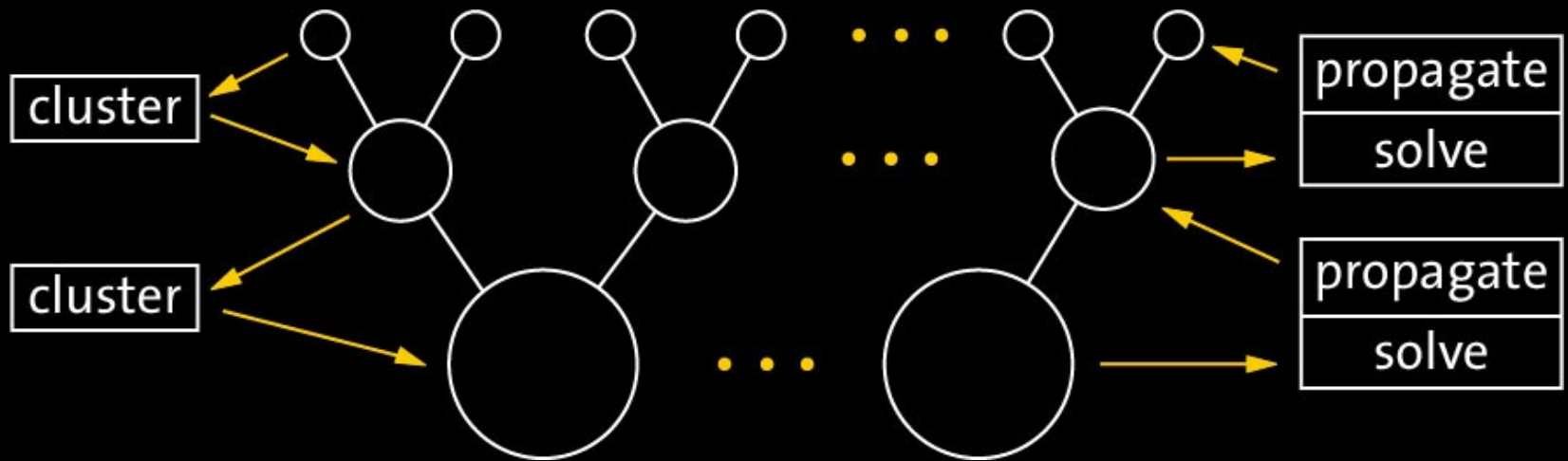


discrete  
curvature

k-  
neighborhood

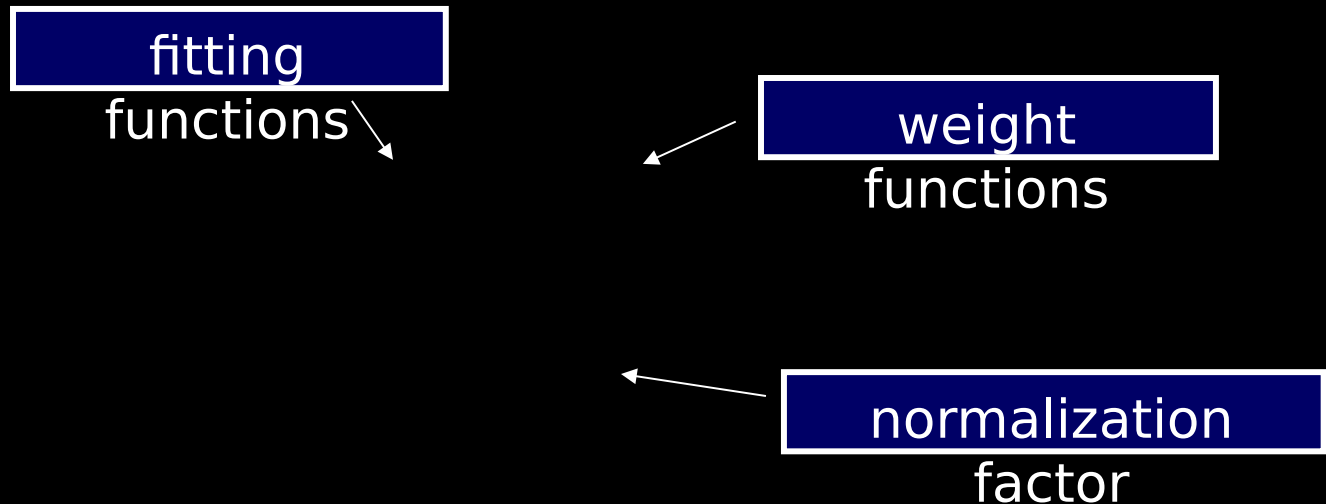
# Point Cloud Parameterization

- Discrete formulation:
  - Leads to a linear least squares system
  - Efficiently solved using multi-grid approach



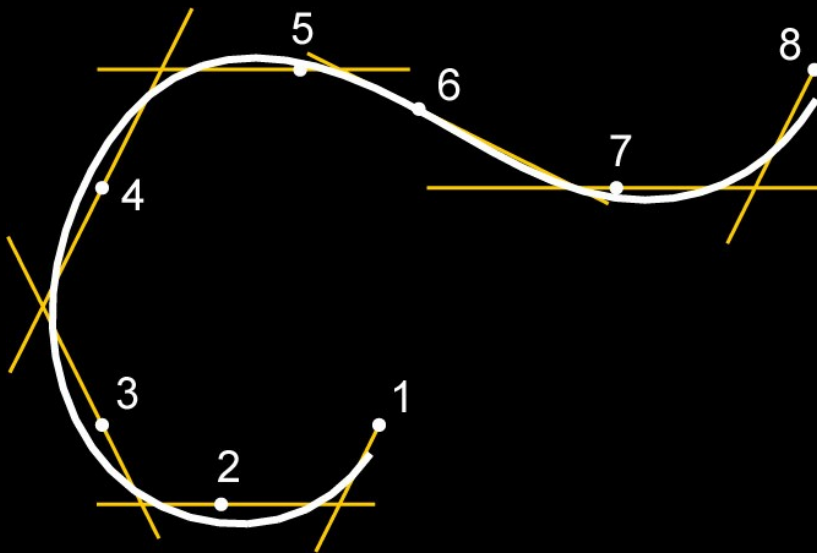
# Reconstruction

- Parameterized scattered data approximation

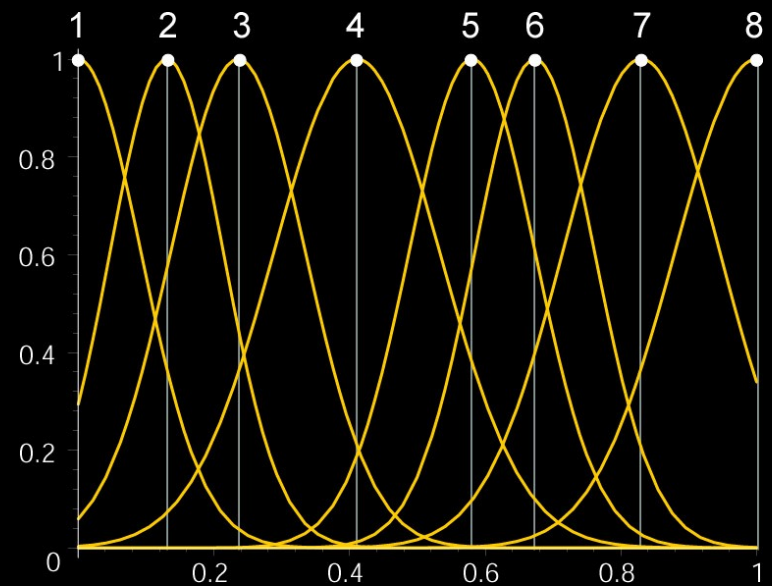


- Compute local fitting functions using local parameterization
- Map to global parameterization using global parameter coordinates of neighboring points

# Reconstruction



reconstruction with  
linear fitting  
functions



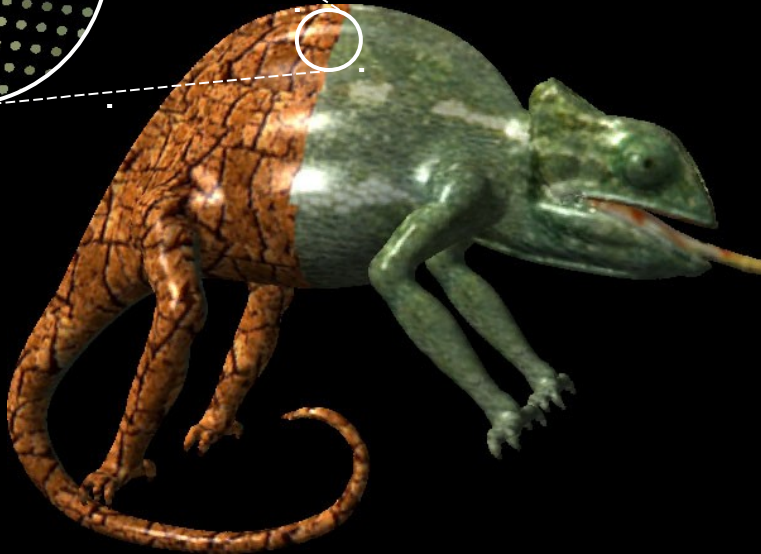
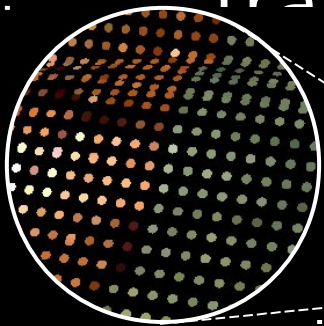
Gaussian weight  
functions in parameter  
space

# Sampling

- Three sampling strategies:
  - Sample at the original surface points
  - Sample at the brush points
  - Adaptive sampling, i.e. sample at surface or brush points depending on the local sampling density
- Antialiasing
  - Band-limit the weight functions (Gaussians) before sampling using Gaussian low-pass filter
    - ⇒ Surface splatting framework

# Editing Operators

- Painting
  - Texture, material properties, transparency

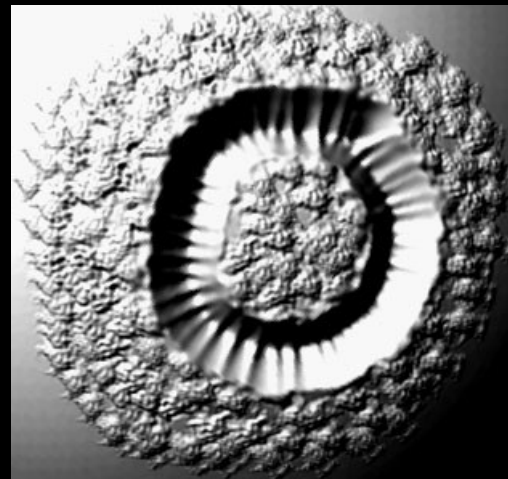


# Editing Operators

- 3D Sculpting



normal  
displacement



carving on a rough  
surface



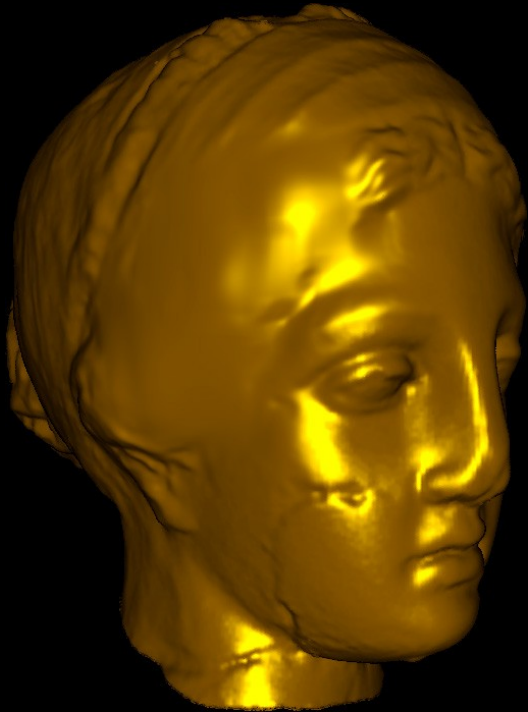
brush  
h



brush  
h

# Editing Operators

- Filtering



geometry smoothing  
filter



artistic texture  
filter

# Demo

# Discussion

- Efficient point-based surface resampling
- Robust reconstruction based on k-nearest neighbors requires:
  - No outliers
  - Sufficiently high, roughly uniform sampling density
  - Little noise
- Geometry editing is restricted to displacements

# Ongoing & Future Work

- Model cleaning
  - User-guided  $\Rightarrow$  provide appropriate tools
  - Automatic pre-process
- More general modeling functionality
  - Free-form deformation
  - Physics-based modeling
- Texture synthesis and transfer

# Conclusion

- Pointshop3D provides sophisticated editing operations on point-sampled surfaces
  - ⇒ points are a versatile and powerful graphics primitive
- Software release in fall 2002 on

[www.pointshop3d.com](http://www.pointshop3d.com)

# Acknowledgements

- Tim Weyrich
- Martin Roth
- CGL, ETH Zürich
- European Graduate Program on Combinatorics, Geometry and Computation
- MERL

